Chapter V

Summary and Conclusion
5. SUMMARY AND CONCLUSION

Pregnancy is a period of rapid growth and cell differentiation, both for the mother and the fetus. Consequently, it is a period when both are very susceptible to alterations in dietary supply, especially of nutrients which are marginal under normal circumstances. The period of intrauterine nourishment, growth and development is one of the most vulnerable periods which affect nutrition status of fetus (Muthayya, 2009).

Mother’s diet should provide adequate nutrients so that maternal stores do not get depleted and the needs of the growing fetus can be met without damaging mother’s health (Singh et al., 2009). Adequate maternal nutrition plays a key role in normal pregnancy progress, optimal fetal development and normal birth weight of the fetous (King, 2000).

The weight of the infant at birth is a powerful predictor of infant growth and survival, and is dependent on maternal health and nutrition during pregnancy (Godfrey and Barker, 2000). Adequate maternal nutrition plays a key role in normal pregnancy progress and optimal fetal development. Proper diet during pregnancy should provide an appropriate amount of energy and all essential nutrients, such as protein, fats, carbohydrates, vitamins and minerals. During pregnancy, additional energy is required for the growth and maintenance of the fetus, the placenta, and maternal tissues (Ebbs et al., 1942; Forsum and Löf, 2007).

Maternal micronutrient deficiency predisposes a mother to poor health, including infection, preeclampsia/eclampsia, and adverse pregnancy outcomes such as premature birth and intrauterine growth retardation (Huffman et al., 1998; Ramakrishnan, 2002). Deficiency of some elements such as calcium, iron and zinc in maternal diet can influence birth weight.

Maternal nutrients intake, normal maternal body mass index before conception, and gestational weight gain are associated with proper fetal development (Baeten et al., 2001; Bolesta and Szostak-Wegierek, 2009; Lu et al., 2003; Neggers et al., 1995). Gestational weight gain during pregnancy influence infant birth weight (Kramer et al., 2002). A strong relationship between maternal pregnancy weight gain and birth weight has been demonstrated consistently and low maternal weight gain is considered as a preventable risk factor for LBW (Matthews et al., 2004). Assessment
of dietary intake during pregnancy is important because it is well established that nutrient deficiencies can have adverse effects on pregnancy outcome (Abu-Saad and Fraser, 2011; Gold, 1971). Unfortunately, effective nutrition guidance in prenatal care is ignored and pregnant women during pregnancy are deprived of nutritional assessment programme. Nutrition guidelines should be improved and the importance of nutrition during pregnancy period should be highlighted. Maternal nutritional factors and consequently birth weight of neonates should be given in high priority.

In Iran, studies on birth weight of neonates and related etiologic factors, especially the nutritional status and micronutrients levels (Calcium, iron, zinc, copper and magnesium) during the three trimesters of pregnancy are very few. Since the relationship between the birth weight of infants and the maternal nutritional status demands further attention, this investigation was carried out in Khoy city which is located in the province of western Azarbajjan with the following objectives:

**Major Objectives:**

- To assess the maternal nutritional and micronutrient status during three trimesters of pregnancy
- To assess the nutritional and micronutrient status of neonates
- To find out the association between maternal micronutrient status and birth weight of neonates.

In order to accomplish the major three objectives of the study, the investigation was carried out in the following phases:

Nine health care centers from the fifteen health centers present in Khoy, along with Gamarbaniashe hospital, were selected to conduct the study. A total number of 450 healthy women with confirmed pregnancy (17-45 years) who started their prenatal care were selected based on their willingness. Written consent letters from all the subjects were obtained and they agreed to be the subjects until the birth of the babies. Suitable questionnaires were formulated to elicit information on details in their family background, dietary intake (24-recall method and food frequency) along with anthropometric measurements (height, weight, upper mid arm circumferences, fundal
height and abdominal circumference). Measurements were taken at the end of the first (14±2 week), second (28±2 week) and third (38±2 week) trimesters. Venous blood specimens were collected from the participating pregnant women at the end of first, second, third trimester of pregnancy. New-born cord blood sample was collected before delivery of placenta. The analysed items consisted of haemoglobin (g/dl blood), calcium (mg/dl), iron (µg/dl), zinc (µg/dl), copper (µg/dl) and magnesium (mg/dl). New-born infants were measured for their somatic status such as weight, height, head and chest circumferences. Biochemical parameters like (haemoglobin, calcium, iron, zinc, copper and magnesium) were employed with the help of the biochemical laboratory. Biochemical assessment was done of the newborn’s umbilical blood for their calcium, magnesium, iron and zinc levels with the help of the biochemical laboratory. The selected methods for haemoglobin assessment was Cyanomethemoglobin (W.H.O/ UNICEF/ UNO, 1998). Inductively Couple Plasma Mass Spectrometer (ICP/MS) (Shariati et al., 2009) was selected for serum calcium, iron, zinc, copper and magnesium analysis.

All other data obtained were subjected to suitable statistical analysis. Mean, Standard Deviation (Mean± SD) and percentages were calculated wherever necessary and suitable tables and graphs were prepared. The statistical differences among the groups were analysed by Student’s t-test, and one-way ANOVA followed by post hoc test. Binary logistic regression analysis was carried out to find the predicting maternal factors in relation to birth weight.

Family Background: Information obtained from women with confirmed pregnancy (N=450) who registered in health care centers was tabulated. The mean age of pregnant women was 26.1±5.8 years and the age range was 18-40 years. Majority (41%) of pregnant women was in age group 26-36 years, followed by the age group 20-26 years (36%).

Pregnancy Related Information of the Subjects: 18% of the pregnant women had experienced abortion in the previous pregnancies. The majority of the subjects were suffering from constipation (85%) followed by nausea and vomiting (68%). Fifty three percent, 45% and 42% of pregnant women had symptoms and signs of mouth and gum discomfort, heartburn, reflux and anaemia respectively.
Food Intake of Pregnant Women: Food intake of pregnant women was assessed at the end of first, second and third trimester using questionnaire. Daily intake of bread and cereals by pregnant women ranged between 482 and 607 gr and the amount of consumption increased significantly as the trimesters increased. Similarly the consumption of pulses, vegetables and fruits in the second and the third trimester was significantly higher than the first trimester. Intake of meat and meat alternatives in the second and the third trimesters were significantly higher than in the first trimester. The consumption of dairy products (144, 182, and 178 grams) by pregnant women in the first trimester was significantly lower than in the second and the third trimester.

Frequency of Food Consumption: Among cereals wheat in the form of bread was the staple cereal that was used daily by 100% of women in all three trimesters. Rice was used daily by 49% and 50% of women in first, second and third trimester. Barley in the form of soup was consumed weekly by 44%, 56% and 50% of subjects in first, second and third trimester respectively. Beans were consumed by 75%, 86% and 78% of women on weekly basis, whereas lentil was used by 68%, 77% and 78% of the subjects during first, second and third trimester respectively. Majority of the subjects used potato by 91%, 97% and 89% daily during first, second and third trimesters respectively. Among the fruits seasonally available fruits like orange, apricot, cherries, apple and watermelon were used on daily basis by 7-65% by pregnant women during three trimesters. Egg and flesh foods were consumed by 39%, 42% and 40% of pregnant women daily during three trimesters. Chicken was consumed daily by 24%, 23% and again 23% during three trimesters and weekly by 64%, 65% and 66% of women, whereas beef was consumed daily by 18%, 20% and 18% and weekly by 51%, 45% and 48% of women during pregnancy period. Mutton was consumed daily by 12%, 11% and 12% and weekly 47%, 42% and 43% during three trimesters.

Milk and Yogurt were consumed daily by 36%, 38% and 40% of subjects during three trimesters respectively. Hydrogenated cooking oil and refined oil were the two types of oils that were used daily by 89% and 78% of pregnant women during the three trimesters.

Food Habits during Pregnancy-Pica: Ninety-two percent of pregnant women (92%) did not avoid foods during pregnancy period; only 8% of them avoided fried food, canned food and soft drinks. Thirty percent of pregnant women in this study had pica.
practice. Thirty-seven percent of subjects showed tendency to consume pickle followed by lavashak (Boiled, dried, sour and salt fruit) (33%).

**Energy and Nutrient Intake of Pregnant Women during Pregnancy and Their Adequacy - Three Trimesters:** The mean energy and protein intake per day by the pregnant women were 1697 kcal, 59.5g 2201 kcal, 77.8g and 2186 kcal, 74.5g during first, second and third trimesters respectively based on the findings of 24 hour recall method. The mean intake of calcium and iron were 688mg, 19.0mg, 865mg, 23.1mg and 855mg, 22.9mg during first, second and third trimesters respectively, while the mean intake of zinc, copper and magnesium during first, second and third trimesters were 9.0mg, 1.39 mg, 236.3mg, 12.5mg, 1.60mg, 307.4mg and 12.3mg, 1.58mg, 295.6 mg respectively.

Percentage adequacy intake with reference to Recommended Daily Allowance (RDA) for energy and protein, in second and third trimester were nearer to adequacy (82- 86%) but in the first trimester, it was significantly lower (77%). Percentage adequacy intake of calcium and iron were also inadequate but iron intake was adequate after including the iron supplements during the second and third trimesters. Percentage adequacy intake of zinc was inadequate whereas magnesium and copper intakes were adequate during pregnancy.

The Energy and nutrient intakes showed a significant increase during pregnancy from first to second trimester whereas the intake of these items in the second and the third trimester were similar.

**Anthropometric Measurements of Pregnant Women - Three Trimesters:** Our findings showed significant differences (p<0.05) among weight, body mass index and upper mid arm circumference according to different trimesters. The anthropometric measurements of the selected subjects at the first prenatal visit in the health centers showed that mean height, weight and BMI were 159.4±4.7, 59.3±8.2 and 22.1±1.9 respectively.

**Gestational Weight Gain during Three Trimesters:** There were significant differences (p<0.05) in gestational weight gain of pregnant women among the three trimesters. The first trimester showed the lowest weight gain whereas the second and the third trimesters weight gain was higher and these results are in consistent with the IOM (Institute of Medicine, 1990) gestational weight gain pattern. In the present
study the mean total weight gain of the subjects during the pregnancy was 12.5±3.0 kg.

According to IOM guideline pregnant women were classified in to three groups, normal weight (52%), overweight (35%) and underweight (13%). Majority of the subjects who gained weight within recommended range were found to have normal weight and overweight before their pregnancy. Unfortunately 22% and 9% of pregnant women who gained weight below recommended gestational weight were normal weight and underweight before their pregnancy respectively.

Haemoglobin Levels During Three Trimesters of Pregnancy: The mean hemoglobin during the second trimester (10.8±0.8) was significantly lower (p<0.05) than the mean haemoglobin in the first (12.3±1.8) and third trimesters (11.4±0.3) of pregnancy. The reduction that was observed in the mean haemoglobin during the second trimester of pregnancy is related to the plasma expansion. In our study seventy-seven percent, 71% and 79% of the subjects had normal haemoglobin during three trimesters of pregnancy. Majority of the anaemic women belonged to mild category, 21%, 26% and 20% in first, second and third trimester respectively. The percentage of women in the moderate categories of anaemia was only 2%, 3% and 1% in first, second and third trimesters respectively. Severe anaemia in the current study was not detected.

Serum Calcium, Iron, Zinc, Copper and Magnesium during Three Trimesters of Pregnancy: In the present study the level of calcium during all trimester was constant (8.96±0.48, 8.86±0.47 and 8.91±0.42 mg/dl).

In the present study the mean serum levels of iron during first, second and third trimesters were 76, 63 and 70µg/dl respectively. Our findings showed that the mean maternal serum iron during pregnancy had a significant difference at 5% level in iron levels during three trimesters. In comparison with the values in the first trimester, serum iron concentration kept decreased in the third trimester. This reflects the fact that the iron stores in pregnant body, gradually fell during pregnancy.

The mean serum zinc during first, second and third trimesters was 79.5, 74.5, 65.3µg/dl respectively whereas mean serum copper levels were 130, 172 and 193µg/dl respectively. There was a significant difference at 5% level in zinc and copper levels during the three trimesters of pregnancy.
The mean serum magnesium during first, second and third trimesters was almost the same (2.10±0.21, 2.08±0.28, 2.09±0.29).

**Prevalence of Serum Calcium, Iron, Zinc, Copper and Magnesium Deficiency in Third Trimester of Pregnancy:** Thirteen percent of pregnant women were hypocalcemic. In the present study, 40% of pregnant women had iron deficiency and 42% of the pregnant women were deficient in Zn. None of the pregnant women were found deficient in serum copper and mg levels.

**Micronutrients Levels in Maternal and Umbilical Cord Blood:** Calcium and iron levels in the newborn’s cord blood were 8.93mg/dl and 106 mg/dl respectively. The mean zinc, copper and magnesium levels in the newborn’s cord blood were 85 µg/dl, 57 µg/dl and 1.99 mg/dl respectively. Iron and zinc levels in maternal serum (70µg/dl, 65µg/dl) were lower than that in cord blood. The mean level of copper in cord blood serum in the current study was lower than maternal values (193µg/dl). The mean serum calcium and magnesium in the serum cord blood and in the serum of pregnant women were similar (8.9mg/dl, 1.9mg/dl).

**Anthropometric Measurements of the Neonates:** Anthropometric measurements of the neonates, namely, weight, height, head, chest and upper mid arm circumferences showed a mean of 3.2 kg, 49.4 cm, 34.7 cm, 33.1 cm and 10.8 cm respectively. The male neonates were heavier, taller and their head and chest circumferences were higher than females.

**Prevalence of Low Birth Weight (<2500g) neonates:** Birth weight was classified according to W.H.O classification in to two categories namely low birth weight (< 2500g) and normal birth weight (≥2500 g). Our findings showed that a majority (89%) of neonates had normal birth weight and only 11% of them were considered as low birth weight.

**Association between Birth Weight and Maternal Attributes –Nutritional Status**

**Association between Birth weight and Maternal Energy and Nutrient Intake:** Our results showed that pregnant women (in third trimester) who consumed 60-79 % of RDA per day (1500-1999 kcal/day) gave birth to neonates with neonate weight (2.6 kg), while the pregnant women with 80-99% of RDA (2000-25 kcal/day) gave birth to neonates with NBW (3.3kg) and with >100% RDA (>2500 kcal) of energy per day gave birth to neonates with 3.6 kg.
The pregnant women with protein intake 60-79 % RDA gave birth to neonates with LBW (2.5 kg) while the pregnant women with higher intake of protein (48-60 g/day or 80-100 % RDA) gave birth to neonates with NBW (2.9 kg) and protein intake >100 % RDA (>60g/day) gave birth to neonates with 3.4 kg.

Pregnant women who consumed calcium less than <80% of RDA gave birth to lighter neonates with 3.0 kg (still in normal weight range), while the pregnant women with 80-100% of RDA and >100% of RDA calcium consumption gave birth to heavier babies (3.3 and 3.5kg).

The pregnant women with iron intake in dietary <80 % of RDA gave birth to neonates with 2.8 kg, while the pregnant women with higher intake of iron (80-100% and >100% of RDA) gave birth to heavier neonates (3.4 and 3.6 kg)

The results of the present study showed that pregnant women who consumed zinc <80% of RDA gave birth to neonates 2.9 kg in compared with women who consumed 80-100% of RDA and >100% of RDA which gave birth to heavier neonates (3.4 kg).
Association between Birth Weight and Anthropometric Measurement of Pregnant Women: Our findings showed that the taller pregnant women (more than 162 cm) gave birth to significantly heavier babies (3.6 kg) than shorter women. Pregnant women with weight less than 65 kg gave birth to neonates with 2.7 kg, while subjects with more than 75 kg gave birth to heavier neonates (3.6 kg). Over weight and obese women gave birth to heavier neonates (3.4 kg), comparing with underweight women (2.7 kg). In the current study pregnant women with higher MUAC (>29 cm) gave birth to heavier babies (3.5 kg, NBW), whereas subjects with less than 25 cm in MUAC gave birth to lighter babies (2.8 kg, NBW).

Birth Weight and Gestational weight gain of the Women: Pregnant women who had gestational weight gain below recommended range gave birth to neonates with birth weight of 2.5 kg, while women within normal recommended range gave birth to heavier neonates (3.3 kg).

Association between Birth Weight and Maternal Biochemical Parameters: Our results demonstrated that pregnant women with haemoglobin less than 9 g/dl, which is considered as anaemia gave birth to neonates with birth weight (2.6 kg), while pregnant women with higher haemoglobin level (>11 g/dl), who were considered as normal, gave birth to heavier and normal babies (3.5 kg). Our findings showed that as the haemoglobin level of pregnant women increased the birth weight of the neonates also increased.

Association between Birth Weight of Neonates and Maternal Factors – Age, Age at Marriage, Education, Occupation and Income of Pregnant Women: In the current study as the age of the women increased from 20-36 the birth weight increased from 3.3 to 3.4 kg. There was a significant progression of birth weight with advancing age. Age at marriage also influenced the birth weight of neonates. In the present study also women who were pregnant for second and third time gave birth to neonates with higher birth weight (3.5 kg), while women with first gravid gave birth to neonates with lower birth weight (2.8 kg). In our study there was not any significant difference between birth weight and mother’s education levels. There was no evidence of any significant difference between birth weight and mother’s occupation in the present study. Total income of family of pregnant women in different levels showed significant influence on birth weight of babies. The pregnant women who had less
than 3 million in Rials per month gave birth to neonates with mean birth weight 2.9kg, while pregnant women with >5 million in Rials per month gave birth to neonates with 3.6kg mean birth weight.

CONCLUSION

It is concluded from the results of the present study that birth weight of the neonates is influenced by the maternal nutritional status. Adequate nutrient intakes (energy, protein, calcium, iron and zinc) are important for appropriate birth weight of the neonates. It was interesting to note the association between factors such as age, parity, income, anthropometric parameters, gestational weight gain, abdominal circumferences, fundal height and nutritional biochemical status of pregnant women and birth weight of their infants in the current study. In order to improve the nutritional status of pregnant women and to optimize their health status which results in the improvement of the neonates, it was useful to analyze indicators that can predict the birth weight of infants. Binary logistic regression was carried out to find the predictor factors when all the maternal nutritional attributes are considered together with reference to birth weight. The findings showed that fundal height, total iron intake, hemoglobin levels calcium intake, family income, protein intake, abdominal circumference, iron intake, energy intake, upper mid arm circumference, and gestational weight gain of women could be considered as “prediction factors” for birth weight of neonates.

SUGGESTIONS

These studies would enable the appropriate intervention strategies to be developed, implemented, and evaluated. Such efforts will require the collaboration and commitment of government agencies, health care providers, nutritionists, research institutions, and the community. Our findings may help the government and non-government agencies to concentrate on efficient performance education workshops on prenatal care and maternal nutritional status, considering that appropriate gestational weight gain has a close connection to birth weight of the neonates.